

parent application.

Furthermore, the specification has been amended to more fully cover the two-dimensional detector originally disclosed in the parent application.

The specification, claims and figures have been amended in other parts as well to more fully cover certain aspects of the invention.

**DISCUSSION OF REJECTED CLAIMS 1 AND 2**  
**UNDER 35 U.S.C. §103**

The Examiner rejected claims 1 & 2 under 35 U.S.C §103 as being unpatentable over Heckman in view of Tsuchiya ('918). Claims 1 and 2 have been amended. Specifically, the Examiner asserted, "[i]t would have been obvious to one of ordinary skill in the art at the time of the invention to modify the imaging system of Heckman by inserting the streak tube of Tsuchiya ('918) behind the objective lens (16) for the purpose of displaying a time dependent image as taught by Tsuchiya."

Applicant respectfully disagrees with the Examiner's assertion. Heckman does not teach or suggest utilizing all, or substantially all, of the reflected portion of the pulse beam to generate three-dimensional data sets, as in the present invention. The present invention utilizes all of the information returned from each pulse to create three-dimensional data sets. Specifically, claim 1 recites in part "...means for generating a volume display utilizing all, or substantially all, of reflected portion of said pulse beam...." In operation, coverage of a volume of the water is obtained by issuing a series of discrete pulse beams to illuminate adjacent slices of the water. After processing the successive slice images, the sections can be displayed to show a scan

through a volume of the medium.

Heckman does not teach utilizing all, or substantially all, of the reflected portion of a pulse beam to generate a volume display, as in the present invention. In contrast, Heckman teaches illuminating a volume of the medium, and by range gating, selecting a specific section of the illuminated volume. Thus, by taking slices of the illuminated volume through range gating, Heckman teaches away from the limitation of providing a full depth realization in a single pulse. Teaching away from the art is a *per se* demonstration of lack of *prima facie* obviousness. In re Dow Chemical Co., 837 F.2d 469, 5 USPQ 1529 (Fed. Cir. 1988); In re Fine, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Specifically, in Heckman, the signal above and below the selected range gate is rejected. Consequently, of the energy transmitted into the volume of the medium, Heckman's system makes use of only a small amount of the return on collecting data from any given pulse. Three dimensional information is obtained only by collecting data from many pulses, during which time the aircraft, or other vehicle must remain stationary. A large multiplicity of shots is required to create an image, thus wasting energy from the laser. As explained in column 5, lines 37-49, "[a]t the moment when the light reflected from a point 7 1/2 feet from the camera is returned, the gate pulse, Wave A, FIG. 2, actuates the camera tube to its open shutter condition. The gate signal enables the camera to collect the light returning to the camera tube during the period that the pulse, Wave A, is applied across the image converter tube, yielding a depth of field of optical image of approximately 7 1/2 feet starting at the 7 1/2 foot

minimum distance determined by the delay. The high intensity flash of light reflected from target 56 produces a stored charge image of the object on the target plate of the image orthicon tube 22. When the signal terminates, the pickup tube once more returns to its closed shutter condition." Thus, unlike the Heckman device, and other prior art gated imaging systems, which reject parts of the signal above and below the selected range gate, Applicant's invention provides a full depth realization in a single pulse.

Additionally, Heckman fails to teach or suggest illuminating a thin slice of a turbid medium, as in the present invention. Specifically, claim 1 of the present invention recites in part "...laser means for generating a pulse beam substantially uniform in intensity to illuminate a thin slice of said turbid medium...." Thus, the present invention takes slices of the turbid medium in vertical planes, along the line of propagation. In contrast, Heckman teaches illuminating a volume of the medium. As explained in column 4, lines 34-39, "[l]aser 14 is also provided with a divergent lens system 50, FIG. 1, providing a cone of illumination 52 having an included angle which is suited for the intended ranges of operation of the system. The objective lens 16 for the television camera provides a matching cone of view 54." Thus, unlike the Heckman device, which illuminates a volume of the medium, Applicant's invention illuminates a thin slice of the medium.

Furthermore, Heckman does not teach or suggest "a field-limiting slit disposed in front of said cathode for rejecting multiply reflected light", as recited in claim 1 of the present invention. Specifically, the reflected portions 30 of the pulse

beam are collected and focused on the photocathode 32 of a streak tube 34 by an optical element, such as a lens 36. The image, which includes a wide spread of scattered light is chopped by the field limiting slit 126 which is aligned with the image of the fan beam, and serves to reject scattered light as well as limit the width of the electron image to a width smaller than the temporal sampling obtained by the pixels in the imaging detector. Because of the narrow fan illuminated and the narrow field limiting slit at the cathode, the light collected is substantially directly reflected light, and not light multiply reflected by the medium. Heckman does not teach or suggest a coincident field-limiting slit, a primary advantage of the present invention.

Moreover, Heckman fails to teach or suggest a "two-dimensional detector means operatively connected to said streak tube for detecting said two-dimensional signal", as recited in Applicant's claim 1. In the present invention, the electron output of the anode 44 is converted to photons again by means of a phosphor layer 46, so that the image of the temporal variation over the narrow fan-shaped pulse beam 12, now converted to a two-dimensional image, can be coupled to a two-dimensional detector array 48 by means of a fiber optic 120, or by a lens 50.

Furthermore, Heckman does not teach or suggest "generating a pulse beam substantially uniform in intensity", as recited in claim 1 of the present invention. Heckman merely teaches using a diverging lens to create a cone of light covering the area of interest. In contrast, Applicant's invention redistributes the light energy so that the energy is at the ends of the fan where the light returned is going to be least, due to range losses.

Additionally, the Examiner rejected claims 1 and 2 under 35 U.S.C. §103 as being unpatentable over Heckman in view of Tsuchiya ('918). Applicant respectfully disagrees with the Examiner's assertion. The application of a streak tube, as taught by Tsuchiya ('918) to the Heckman system would make the Heckman system inoperable. References are not properly combinable or modifiable if their intended function is destroyed. Specifically, a 35 U.S.C. §103 rejection based upon a modification of a reference that destroys the intent, purpose or function of the invention disclosed in the reference, is not proper and the prima facie case of obviousness cannot be properly made. In short, there would be no technological motivation for engaging in the modification or change. To the contrary, there would be a disincentive. In re Gorden, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed Cir. 1984).

In this case, if the imaging system of Heckman was modified by inserting the streak tube of Tsuchiya ('918) behind the objective lens (16), it would be rendered inoperable for its intended purpose of displaying a time dependent image. As described above, Heckman illuminates a volume of the medium, and by range gating selects a specific section of the illuminated volume, which corresponds to a horizontal slice, or a slice normal to the direction of propagation. Three dimensional information is obtained only by collecting data from many pulses, during which time the aircraft, or other vehicle must remain stationary. If each frame from this system were displayed in sequence on a television, the result would be a sinking image descending through the water, and then a jump to a new frame when the sequence begins again. A large multiplicity of shots is thus required to create an image, thus wasting energy from the

laser.

A single range gate image cannot be obtained with a streak tube. A streak tube, such as that disclosed in Tsuchiya ('918) cannot select a specific section of the illuminated volume, which corresponds to a horizontal slice, or a slice normal to the direction of propagation. Consequently, instead of a close proximity focused image converter tube, the entire two-dimensional distribution would be smeared since each time slice of the area image would be shifted and added to the two-dimensional image from the preceding time slice.

In light of the foregoing discussion, Applicant respectfully submits that independent claim 1, and claims 2-5 which depend therefrom, are patentable over Heckman.

**DISCUSSION OF REJECTED  
CLAIMS 3, 5, 7, 8, 11, 13, AND 15-17  
UNDER 35 U.S.C. §103**

**Claim 3**

The Examiner rejected claim 3 under 35 U.S.C. §103 as being unpatentable over the combination of Heckman and Tsuchiya ('918) in view of Takaoka. The limitations of claim 3 in the prior application have been incorporated in claims 1, 6, 7 and 8 of the present application. Specifically, the Examiner asserted, "[i]n regard to claim 3, the combination of Heckman and Tsuchiya ('918) discloses the invention as claimed except for the step of using a sequence of samples to generate a volume display....It would have been obvious to one of ordinary skill in the art at the

time of the invention to mount the streak tube imaging system of Heckman and Tsuchiya ('918) on a vehicle in order to collect a sequence of samples which are needed to generate a volume display as taught by Takaoka."

Applicant respectfully disagrees with the Examiner's contention. In addition to the comments made in response to the above rejections, Applicant respectfully points out that none of the cited references, including Heckman, Tsuchiya ('918) and Takaoka, teach or suggest the generation of a volume display, as claimed in claims 1, 6, 7 and 8 of the present invention.

Specifically, the Examiner asserted, "Takaoka teaches an imaging system which uses vehicle motion to obtain a sequence of samples (see. col. 1 ln 58-63 and Fig. 1)." Col. 1, ln 58-63 states in part, "...there has been proposed a device illustrated in FIG. 1 which radiates narrow beams of linear laser light to the ground surface in a direction perpendicular to that in which an airplane travels and scans the ground surface by said beams as it moves on so as to obtain ample information."

Applicant respectfully disagrees with the Examiner's assertion and points out that the laser light referred to in Takaoka emanates from a continuous wave (CW) laser. As stated in col. 2, lines 12-15, "[w]ith any of the prior laser light systems, a laser light was transmitted to the ground in a continuously oscillated form and in consequence the reflected light was also received continuously." The application of an CW imaging system which uses vehicle motion to obtain a sequence of samples, as taught by Takaoka in reference to prior art, to the combination of Heckman and Tsuchiya ('918) would make the combination inoperable. References are not properly

combinable or modifiable if their intended function is destroyed. Specifically, a 35 U.S.C. §103 rejection based upon a modification of a reference that destroys the intent, purpose or function of the invention disclosed in the reference, is not proper and the prima facie case of obviousness cannot be properly made. In short, there would be no technological motivation for engaging in the modification or change. To the contrary, there would be a disincentive. In re Gorden, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed Cir. 1984).

Additionally, the Examiner asserted, "Takaoka also teaches a method of generating a volume display using time information (see col. 2 ln. 58-62)." Col. 2, ln 58-62 states in part, "...information relating to the three-dimensional condition of said foreground object can be obtained from the difference between the time of radiating the laser and that of receiving it." Applicant respectfully disagrees with the Examiner's assertion. Takaoka does not teach generating a time display, as in the present invention. Rather, Takaoka merely teaches generating a surface display. Specifically, Takaoka teaches gating the return of the pulse so that a surface is isolated from other scattered return above and below the surface to improve the contrast of the selected image plane. A surface display is then created. Thus, the three-dimensional condition referred to in the Takaoka patent refers to information, not display.

None of the cited reference, including Heckman, Tsuchiya ('918) and Takaoka, teach the step of using a sequence of samples to generate a volume display, as disclosed in the Applicant's invention. As a consequence, the cited references provide absolutely no motivation to make a combination of isolated features as



proposed by the Examiner. In light of the foregoing discussion, Applicant respectfully submits that the claims are patentable over Heckman.

Claims 5, 7, 8, 11, 13 & 15-17

The Examiner additionally rejected claims 5, 7, 8, 11, 13 and 15-17 under 35 U.S.C. §103 as being unpatentable over the combination of Heckman and Tsuchiya ('918) in view of Takaoka. The limitations found in independent claim 5 of the prior application are now found in independent claim 19 of the present application.

Applicant respectfully disagrees with the Examiner's invention, in light of the aforementioned arguments presented in response to rejection of claim 1 of the present invention. Specifically, Heckman does not teach or suggest utilizing all, or substantially all, of the reflected portion of a pulse beam to generate a volume display, as in the present invention. Additionally, Heckman fails to teach or suggest a field limiting slit disposed in front of a cathode for rejecting multiply reflected light. Nor does Heckman teach or suggest optical means disposed in front of the field-limiting slit for imaging the reflected portion of the pulse beam on the field-limiting slit. Additionally, the application of a streak tube, as taught by Tsuchiya ('918) to the Heckman system would make the Heckman system inoperable. References are not properly combinable or modifiable if their intended function is destroyed.

As a consequence, the cited references provide absolutely no motivation to make a combination of isolated features as proposed by the Examiner. In light of

the foregoing discussion, it is submitted that independent claim 19, and the claims which depend therefrom, are patentable over the cited references.

DISCUSSION OF REJECTED CLAIMS 9 AND 10  
UNDER 35 U.S.C. §103

The Examiner additionally rejected claims 9 and 10 under 35 U.S.C. §103 as being unpatentable over the combination of Heckman and Tsuchiya ('918), and Takaoka as applied to claim 5 above, and further in view of Tsuchiya ('386). The limitations found in claims 9 and 10 of the prior application have been incorporated into claims 25 and 26, respectively, in the present application. Applicant respectfully disagrees with the Examiner's assertion based upon the arguments made above with respect to independent claim 19, from which claims 25 and 26 depend.

DISCUSSION OF REJECTED CLAIM 14  
UNDER 35 U.S.C. §103

The Examiner additionally rejected claim 14 under 35 U.S.C. §103 as being unpatentable over the combination of Heckman and Tsuchiya ('918), and Takaoka as applied to claim 5 above, and further in view of Scott. The limitation found in claim 14 in the prior application has been incorporated into claim 30 in the present application. Applicant respectfully disagrees with the Examiner's assertion based upon the arguments made above with respect to independent claim 19, from which claim 30 depends.